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June 22, 2018

By Electronic Filing

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, S.W.
Washington, D.C. 20554

Re: Sirius XM Written *Ex Parte* Presentation, GN Docket No. 17-183

Dear Ms. Dortch:

Attached on behalf of Sirius XM Radio Inc. ("Sirius XM") is a response to filings from parties supporting the deployment of unlicensed radio local area network ("RLAN") devices in frequencies including the 7025-7075 MHz band, the sole feeder link spectrum Sirius XM can use and is licensed to use to provide satellite digital audio radio service ("SDARS") to over 33 million U.S. customers. The response demonstrates that contrary to the claims of RLAN proponents, permitting RLANs in the 7025-7075 MHz band would create unacceptable interference to SDARS operations and should not be allowed.

The paper explains that despite Sirius XM's efforts to provide its subscribers with interference-free service, in parts of the country SDARS already is subject to interference in the downlink frequency bands, leaving no margin to tolerate additional interferers. The proposed deployment of unlicensed RLAN devices in quantities projected to approach 1 billion units by 2025 would create aggregate interference at SDARS satellite radios that would significantly compound the existing interference many subscribers receive today.

Claims that RLAN operations would be compatible with SDARS are based on unrealistic usage and performance assumptions. Altering just a few of these assumptions to reflect more reasonable parameters results in pronounced and wholly unacceptable increases in interference that would disrupt SDARS service.

These are not simply theoretical concerns. A recent filing by Globalstar explains that just a few years after the Commission modified its rules to permit outdoor unlicensed devices in the 5 GHz frequencies Globalstar uses for its feeder links, the company measured substantial and unacceptable increases in the noise floor. Sirius XM demonstrates in the attached paper that a comparable noise floor increase in the Sirius XM feeder link band would similarly undermine SDARS quality and reliability.

Addressing and correcting such problems after the fact would be difficult, if not impossible. Once RLAN devices are in the hands of users, the Commission would have no means to effectively even identify devices that are responsible for interference, much less ensure that those devices terminate transmissions.

In short, permitting RLAN operations in SDARS feeder link spectrum would degrade SDARS service quality, undermine the Commission's ability to enforce requirements that unlicensed devices not cause interference to licensed systems, and ultimately compromise the satellite radio service. Such an outcome is clearly contrary to the public interest. To avoid these harms, the Commission should reject proposals for RLAN use of the 7025-7075 MHz SDARS feeder link band.

Please address any questions regarding these matters to the undersigned.

Respectfully submitted,

/s/ Karis A. Hastings

Karis A. Hastings
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Attachment

Response of Sirius XM Radio Inc. to

Analysis of RKF Engineering LLC:
"Frequency Sharing for Radio Local Area Networks in the 6 GHz Band"

June 22, 2018

INTRODUCTION

Sirius XM Radio Inc. ("Sirius XM") provides satellite digital audio radio service ("SDARS") to over 33 million customers (and over 100 million vehicles equipped with satellite radios), using spectrum in the 7025-7075 MHz band to uplink its service to a fleet of satellites transmitting in the 2320-2345 MHz band. Sirius XM responds herein to a paper submitted by RKF Engineering ("RKF") in GN Docket No. 17-183.[1] RKF argues that unlicensed Radio Local Area Networks or "RLANs"[2] can successfully operate in the 5925-7125 MHz frequencies (the "6 GHz band") without creating unacceptable interference to satellite operations, including SDARS, in this spectrum.

Sirius XM strongly disputes these contentions. The Sirius XM network has been designed to meet the extremely high reliability expectations of SDARS subscribers and has no available margin for any additional interference. Notwithstanding the resource-intensive measures Sirius XM has taken to maximize its system's performance, Sirius XM experiences interference today that impacts the quality and availability of the signal received by listeners. Authorizing hundreds of millions of unlicensed devices to operate in the 7025-7075 MHz band, which is the sole feeder link spectrum available for SDARS, would increase the noise level in the uplink transmission received by SDARS space stations, which in turn would degrade the integrity of the programming signal delivered to listener radios in the 2320-2345 MHz band.

Such degradation, stemming from the aggregate effect of devices scattered over the nationwide receive beam coverage of SDARS satellites, would be impossible for the Commission to reverse. The Commission would have no control over the number of unlicensed RLAN devices deployed and no means to effectively identify and require termination of interfering transmissions. As a result, Commission rules specifying that unlicensed devices cannot cause harmful interference to licensed services or requiring that devices cease operating if interference occurs[3] would be rendered meaningless. The infeasibility of redressing interference in this circumstance requires the Commission to exercise extreme caution in determining whether to permit unlicensed operations in the first place.

RKF's conclusion that RLAN deployment would not harm SDARS operations is flawed because it rests on a number of questionable assumptions. Despite claiming that its study relies on conservative data or even represents a worst-case scenario, in many cases RKF's results are premised on predictions regarding future RLAN deployment, usage, and performance characteristics that significantly underestimate the interference threat to SDARS. Varying just a

[1] Frequency Sharing for Radio Local Area Networks in the 6 GHz Band, prepared by RKF Engineering Services, LLC, Attachment to *Ex Parte* Filing of Apple Inc. *et al.*, GN Docket No. 17-183, filed Jan. 25, 2018 ("RKF").
[2] As RKF explains, RLAN is a generic term that encompasses a variety of devices that provide local area network connections. RKF at 4 n.3.
[3] 47 C.F.R. § 15.5.

few of these inputs to reflect more realistic projections significantly increases the expected interference to a level that would be destructive to SDARS signal quality.

A recent submission by Globalstar, Inc. ("Globalstar") concretely demonstrates both the pitfalls of relying on interference projections and the risks of allowing large numbers of unlicensed devices to operate in spectrum licensed for satellite uplink operations.[4] Specifically, Globalstar explains that just a few years after the Commission modified its rules to allow deployment of Unlicensed National Information Infrastructure ("U-NII") devices outdoors and at increased power levels in the same 5150-5250 MHz frequencies Globalstar uses for feeder links for its licensed mobile-satellite service ("MSS") constellation, Globalstar has measured increases in the noise floor that are double what U-NII proponents had calculated would be peak interference levels.[5] As discussed herein, comparable increases in the noise floor resulting from unlicensed device deployment in the SDARS feeder link spectrum would seriously degrade the reliability and quality of the SDARS service received by Sirius XM's subscribers.

Such an outcome would harm U.S. consumers, compromise the value of Sirius XM's multibillion dollar investment in its network, and violate long-established Commission principles requiring the protection of licensed services from interference caused by unlicensed devices. Moreover, if RLAN deployment were permitted in Sirius XM's feeder link spectrum, the erosion of SDARS signal quality would be difficult to halt and virtually impossible to reverse given the Commission's lack of practical control over devices in the hands of end users.[6] Instead, the Commission must prevent this impairment of Sirius XM's operations from occurring by denying proposals for unlicensed use of the 6 GHz frequencies used for SDARS feeder links.

DISCUSSION

Sirius XM uses the 7025-7075 MHz band to provide six continuous uplinks to the four active satellites in our constellation, which transmit SDARS programming for distribution throughout the network's North American service area. In addition, this spectrum is used to send command signals that are essential for controlling all five Sirius XM spacecraft, including the in-orbit spare satellite Sirius XM deployed to enhance service reliability. Figure 1 below depicts the overall system diagram with the uplink, downlink and command channel frequencies. Interference introduced into the signal at any point – in the uplink or in the downlink – adversely affects the service quality for subscribers and users.

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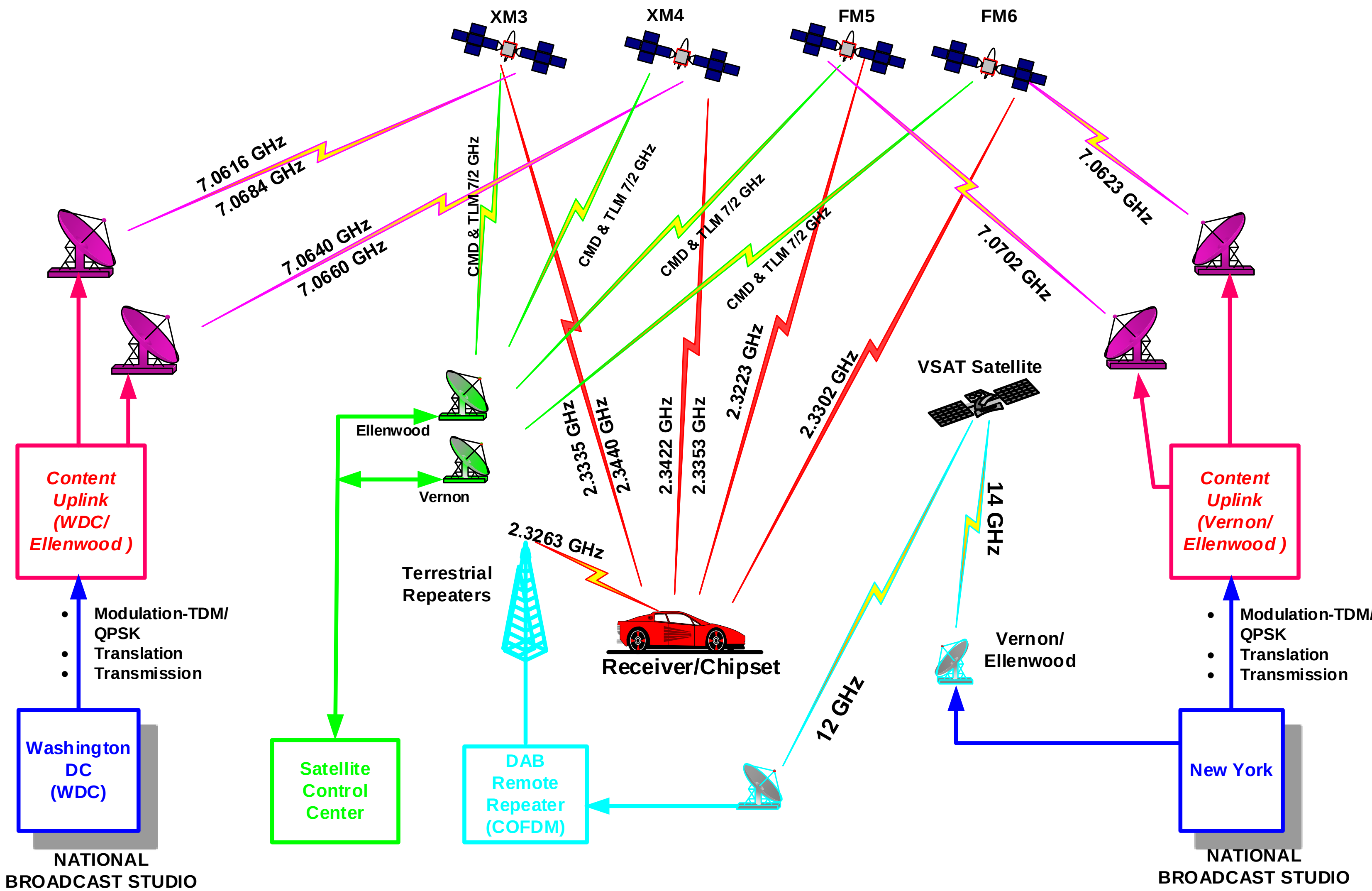
[4] Globalstar, Inc. Petition for Notice of Inquiry, RM-11808, May 21, 2018 ("Globalstar Petition"), available at: https://ecfsapi.fcc.gov/file/1052171263995/Globalstar%20Petition%20for%20Notice%20of%20Inquiry%20filed%20052118.pdf.

[5] *Id.* at 2 & n.7.

[6] Suggestions from RLAN proponents that mitigation techniques can effectively limit RLAN interference to satellites are unsupported. *See* Letter from Apple Inc. *et al*., GN Docket No. 17-183 (June 12, 2018) (the "June RKF Letter"). For example, limiting "radiated emissions of all outdoor 6 GHz RLAN devices with antennas pointing more than 30 degrees above the horizon to 1 W or less," *id.* at 5, would not prevent harm to SDARS. As discussed below, Sirius XM has assumed an RLAN power level of 1 watt in calculating the adverse effect of RLAN transmissions.

<u>Figure 1. Sirius XM SDARS Transmission System</u>



I. THE SIRIUS XM SERVICE HAS NO MARGIN TO ACCEPT ADDITIONAL INTERFERENCE.

RKF does not supply any analysis regarding the potential for interference from RLAN devices into SDARS networks. Instead, RKF's calculations of RLAN interference into satellite operations focus solely on fixed-satellite service ("FSS") in the 5.925-6.425 GHz conventional C-band, ignoring the impact on operations in the 7025-7075 MHz band.

RKF justifies this choice through an exercise in circular reasoning. RKF observes that conventional C-band is the most widely used band segment, with satellites separated by two degrees. RKF then notes that with densely deployed spacecraft, adjacent satellite interference "is a key driver for system margin," leading to the use of earth stations with high gain that are typically at least 2.4 meters or larger.[7] RKF concludes that because adjacent satellite interference is greatest in the conventional C-band, that segment has "the most challenging sharing environment."[8]

In other words, having considered only densely deployed satellites in deciding what makes an interference environment challenging, RKF not surprisingly decides that the most challenging interference environment occurs where there are densely deployed satellites. RKF ignores the fact that for SDARS networks, factors other than adjacent satellite interference are most significant in determining link margins and service availability. Rather than using large, high-gain antennas like those typical for C-band FSS operations, Sirius XM must deliver a continuous, reliable signal to consumer-grade mobile terminals with very low gain antennas traveling through a variety of diverse and changing propagation scenarios, ranging from the jam-packed thoroughfares of urban canyons to foliage-covered rural roads to highways traversing open plains.

That does not mean that the sharing environment for SDARS is any less challenging than it is for FSS. To the contrary, the Sirius XM network experiences documented interference today from a variety of licensed transmission sources, despite the company's use of every reasonable mitigation approach, and the satellite radio service cannot tolerate the addition of interference from RLAN devices in SDARS feeder link spectrum.

In calculating Sirius XM's system performance, the critical number is the transmission Carrier to total Noise ratio measured at the SDARS mobile subscribers' receivers. The total noise value reflects the combined uplink and downlink thermal noise and aggregate combined interference noise in both the uplink and downlink transmissions.

Sirius XM's objective is to have continuous subscriber reception at least 99.9% of the time outdoors, which excludes periods in which reception is blocked by major obstructions such as tunnels and parking garages. This performance objective is required due to competitive

[7] RKF at 36.
[8] *Id.* at 37.

considerations and to satisfy satellite radio customers' expectations of near-continuous service availability.

Satellite radio signal quality defined by its Carrier to Noise Ratio must also be sufficiently robust to overcome outages from foliage attenuation. Foliage attenuation occurs over much of the United States, and its attenuation value is a function of locality, elevation angle of the mobile subscriber's antenna to the satellite, and time of year.[9]

Since commencing operations, Sirius XM continues to work towards this 99.9% availability objective – despite increasing interference from multiple sources and spectrum congestion – using a variety of mitigation techniques. As shown in Figure 1, the Sirius XM system was designed to employ satellite spatial diversity, satellite time diversity, satellite frequency diversity, transmission data interleaving, and deployment of terrestrial repeaters in core urban areas to increase signal reliability. In addition, Sirius XM has enhanced its system's performance over time by launching more powerful satellites, using transmitting beams shaped by 30-foot diameter satellite antennas, improving subscriber radio sensitivity, and optimizing the use and location of the terrestrial repeaters in its network.

Despite the foregoing substantial and resource-intensive efforts, Sirius XM has experienced a significant and growing problem of interference disrupting the SDARS service. The largest contributors are emissions from Wireless Communications Service ("WCS") operations at 2305-2320 MHz and 2345-2360 MHz, directly adjacent to the licensed Sirius XM downlink spectrum at 2320-2345 MHz, as well as third order intermodulation products from transmissions in the Advanced Wireless Service ("AWS") band at 2110-2155 MHz and the Personal Communications Service ("PCS") band at 1850-1990 MHz.

The Commission is well aware of Sirius XM's ongoing interference concerns.[10] Sirius XM's practice has been to address these interference issues directly with the responsible terrestrial licensees, all of which have been large, experienced telecommunications network operators that understand interference principles and have been generally responsive to Sirius XM's concerns. These labor-intensive and time-consuming efforts at least provide an avenue to attempt to resolve the disruptions to Sirius XM's service.

In addition to these factors directly affecting the Sirius XM downlink signal, Sirius XM uplink signals are subject to interference from other services that already share spectrum in the 6 GHz band, including terrestrial Fixed Service ("FS") microwave links, television Broadcast Auxiliary

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[9] *See generally* Dr. Julius Goldhirsh & Dr. Wolfhard J. Vogel, "Propagation Effects for Land Mobile Satellite Systems: Overview of Experimental and Modeling Results," NASA Reference Publication 1274 (1992), available at: https://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/19920011162.pdf.

[10] *See, e.g.,* Letter from Sirius XM Radio Inc., WT Docket No. 07-293 (Feb. 14, 2017) (describing tests demonstrating interference to Sirius XM operations from WCS transmissions); *Applications of Cellco Partnership d/b/a Verizon Wireless and T-Mobile License LLC*, FCC File Nos. 0006867447 *et al.*; Letter from Sirius XM Radio Inc., RM-11750 (Aug. 7, 2015) (detailing Sirius XM's experience with intermodulation interference from certain AWS and PCS networks).

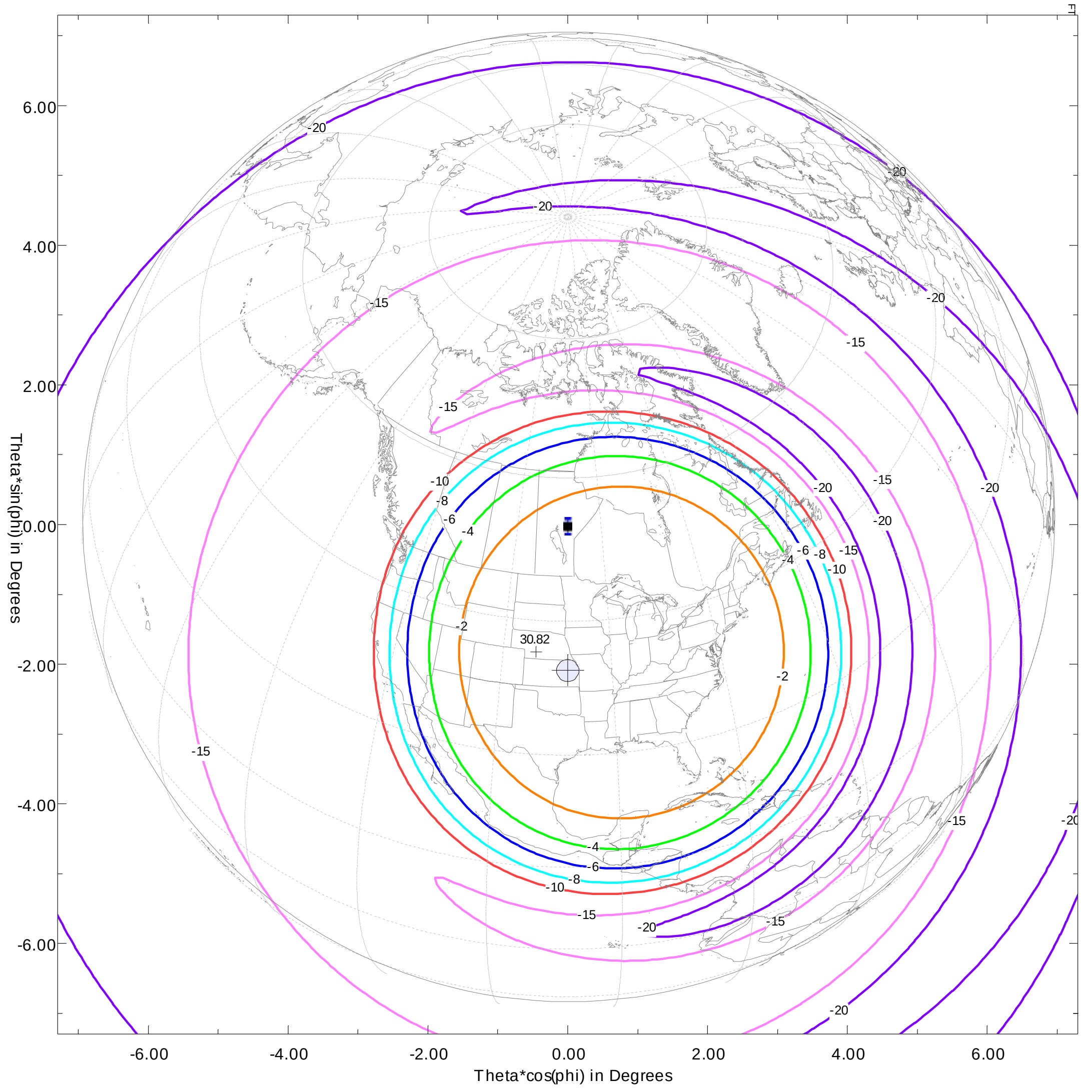
Service ("BAS"), Cable Television Relay Service ("CARS"), and Local Television Transmission Service ("LTTS").

The Sirius XM service cannot tolerate the introduction of a new source of interference. The significant and increasing noise contribution from these multiple sources affecting the SDARS signal means there is no margin for further interference due to the proposed unlicensed RLAN transmissions in the licensed Sirius XM uplink spectrum.

Figure 2 below illustrates the vulnerability of Sirius XM satellites to additional interference in the uplink spectrum, depicting a receive antenna pattern projected on the earth that is typical of both the active Sirius XM satellite fleet and the next-generation spacecraft Sirius XM is constructing.[11] Given the large beam coverage, all terrestrial transmitters operating in the 7025-7075 MHz band throughout the United States would cause uplink interference into all four active Sirius XM satellites. The received interference power flux density at the satellite is amplified by the satellite antenna gain – over much of the United States, by a factor of 800. More significantly, the interference from these transmitters is additive, such that the cumulative impact to Sirius XM reception from these transmitters, in addition to the interference currently received from other sources, could exceed the system interference threshold, causing muting of the Sirius XM service at subscribers' radios.

[11] Applications for two replacement satellites, SXM-7 and SXM-8, are pending before the Commission. *See* Public Notice, Space Station Applications Accepted for Filing, Report No. SAT-01321, June 8, 2018.

Figure 2. Typical SXM Satellite Uplink Receive Antenna Pattern



Thus, any addition to the total noise value resulting from RLAN transmissions would exacerbate the interference Sirius XM is already experiencing. Moreover, the sheer number of unlicensed RLAN devices likely to be operating in the SDARS uplink band not only will significantly increase the interference risk, but will do so in a way that Sirius XM cannot address through coordination agreements or other direct interaction with the offending operators, who will be individual consumers rather than Commission licensees aware of interference risks and their obligation not to cause interference. If this band is to be shared with unlicensed operations, there will soon be millions of devices competing for bandwidth with SDARS uplinks. Each of these devices will be unlicensed by the Commission and each will add some measure of interference into the SDARS band, the aggregate of which will further diminish the viability of operations in a band already suffering from significant interference. The ultimate result would be an unacceptable and irreparable impairment of the signal quality delivered to SDARS subscribers and other users.

II. RKF'S UNREALISTIC ASSUMPTIONS CAUSE IT TO MATERIALLY UNDERESTIMATE RLAN INTERFERENCE TO SDARS OPERATIONS.

As discussed above, because RKF's analysis focuses on FSS rather than SDARS systems, it does not accurately reflect the potential harm to Sirius XM operations that would result from the introduction of RLAN devices in SDARS uplink spectrum. But this is hardly the only defect in the RKF study. RKF's conclusions are premised on questionable or speculative assumed values for several variables that affect the total estimated interference power generated by the proposed RLAN transmissions. Adjusting these values to reflect more realistic scenarios results in significant increases in the predicted interference that will be caused by RLAN operations.

1. Underestimating outdoor use: As other parties have noted, the 2% outdoor use factor relied on by RKF is unproven.[12] Intelsat and SES cite a report by the Electronic Communications Committee of the European Conference of Postal and Telecommunications Administrations (the "CEPT ECC Report"), which relies on an outdoor use factor more than two and a half times as high, 5.3%.[13]

   RKF's response to the Intelsat/SES Letter criticizes the CEPT ECC Report and claims that the sources on which RKF relied in deriving its 2% estimate are superior as they are based on "real-world market research."[14] In a later filing, however, RKF itself cites the CEPT ECC Report, implicitly endorsing its analysis.[15] Moreover, while the CEPT ECC Report is publicly available and was prepared on behalf of European regulatory

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[12] Letter from Intelsat Corporation and SES Americom, Inc., GN Docket No. 17-183 (Feb. 23, 2018) ("Intelsat/SES Letter").

[13] *See id.* at 1-2 & n.5, *citing ECC Report 244, Compatibility Studies Related to RLANs in the 5725-5925 MHz Band*, at 66 (Jan. 29, 2016), available at https://www.ecodocdb.dk/download/97d65d77-816b/ECCREP244.PDF.

[14] Letter from Broadcom Corp. *et al.*, GN Docket No. 17-183 (Apr. 10, 2018) (the "April RKF Letter") at 4.

[15] Letter from Apple Inc. *et al.*, GN Docket No. 17-183 (May 14, 2018) (the "May RKF Letter") at 7-8 & n.43.

agencies, the documents on which RKF's estimate are based are non-public – meaning neither the Commission nor interested parties can review their underlying methodology – and were produced by entities associated with the commercial wireless industry.[16]

In any event, estimating the future percentage of Wi-Fi devices to be used outdoors and indoors is highly speculative due to the rapid increase in the use of mobile end user devices. RKF also seems to assume that all Wi-Fi traffic eventually travels over a fixed connection, but this ignores the increase in mobile Wi-Fi from cellular sources. Connected cars with built in hot-spots, cellular phones serving as Wi-Fi hot spots, and dedicated cellular hot spots will all produce outdoor transmissions. Extrapolating the percentage of outdoor use based on placement of the access point also ignores the boom in Internet of Things ("IoT") devices,[17] including outdoor sensors that still connect to indoor Wi-Fi, such as security cameras, smart doorbells, smart door locks and more. The potential of massively deployed vehicle-to-vehicle or vehicle-to-infrastructure devices is also becoming apparent, as some automobile manufacturers have already begun pilot programs.[18] As a result, the potential number of outdoor transmitters could be substantially higher than originally estimated and can reasonably be expected to grow with time. If RKF is purporting to show a worst-case interference scenario, it should use the higher percentage of outdoor transmitters cited in the CEPT ECC Report.

2. Overestimating wireless link speed: RKF assumes a total RLAN capable device population of 958 million by 2025 and defines 10% of these as high-activity devices during peak times.[19] To determine the amount of time high-activity devices are transmitting, RKF divides the data consumption rate by the wireless link speed, assuming a wireless link speed of 1 Gbps.[20] While this speed is technically achievable, it is not a realistic average for consumer Wi-Fi equipment,[21] particularly in areas with any type of wireless congestion. As network congestion increases, network overhead will significantly lower this wireless link speed, causing data throughput to drop. As a result, the time each device spends transmitting will increase. Because the link speed metric

[16] For example, the Dell'Oro Group report on which RKF relies (RKF at 14 & Fig. 3-2; April RKF Letter at 4 n.11) appears to be available only for a fee. The cite for the 5G Americas and Small Cell Forum document referenced by RKF (RKF at 14 n.11) is to a hyperlink that produces a "Page Not Found" message.

[17] Cisco, "The Internet of Things: How the Next Evolution of the Internet is Changing Everything," available at https://www.cisco.com/c/dam/en_us/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf (discussing projects that place wireless sensors on cows and water pipes).

[18] "Audi launches first Vehicle-to-Infrastructure (V2I) technology in the U.S. starting in Las Vegas," available at https://www.audiusa.com/newsroom/news/press-releases/2016/12/audi-launches-vehicle-to-infrastructure-tech-in-vegas (discussing the launch of technology that allows the car to receive real-time traffic signal information).

[19] RKF at 12-14.

[20] *Id.* at 15.

[21] Indeed, RKF admits that 1 Gbps rates "are not yet ubiquitous in existing unlicensed bands." May RKF Letter at 3.

presented by RKF is a theoretical best case, not a real-world worst-case situation, the usage rate derived by RKF to calculate interference from RLANs is unrealistically low.

3. Underestimating high-activity usage: RKF estimates that 10% of devices will be considered high-activity, consuming 4.44 Mbps for home users.[22] RKF suggests that this rate is "a conservative estimate of the average throughput demands of streaming high-definition video" and that this consumption is unlikely to change between now and 2025, predicting that better compression technology will keep pace or exceed the rate of increased demand for higher definition quality.[23]

   RKF's assertions appear to be incorrect on both counts. Currently, Netflix recommends 3 Mbps for standard definition video quality, 5 Mbps for high definition video quality, and 25 Mbps for ultra-high definition video quality.[24] Thus, a data rate of 4.44 Mbps for a high activity residential user is low, even by today's standards. Moreover, a Cisco whitepaper estimates that consumer internet video in North America will increase at a 24% compounded annual growth rate for 2016-2021,[25] and content delivery network traffic in North America will increase at a 38% compounded annual growth rate over the same period.[26] Projecting this growth rate out to 2025 to be in line with the time frame of the RKF predictions would suggest that North American video traffic would increase almost seven times, and North American content delivery network traffic would increase over eighteen times, as compared to 2016 levels. With such large projected increases in data usage, RKF's assumed high-activity usage rate of 4.44 Mbps appears unrealistically low.

   In fact, always-on and high-throughput applications such as video surveillance are likely to become even more prevalent if a 6 GHz unlicensed band were made available. These applications will continuously transmit large amounts of data, possibly pushing the proportion of high-activity users even higher than the 10% assumed by RKF.

   Once again, RKF has picked best-case values that make the interference risk appear low. A higher data consumption rate will increase the average time each device is actively transmitting, increasing the interference potential from RLAN operations. Considering Cisco's own industry projections,[27] it is not unreasonable to expect that a high-activity user in 2025 will be consuming ten times more data than RKF estimates, 44.4 Mbps

[22] RKF at 15.
[23] May RKF Letter at 3 & n.21.
[24] Netflix Internet Connection Speed Recommendations, available at https://help.netflix.com/en/node/306.
[25] Cisco Visual Networking Index: Forecast and Methodology, 2016–2021, Table 11, available at https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html ("Cisco Whitepaper").
[26] *Id.* at Table 12.
[27] *See* Cisco Whitepaper.

rather than 4.4 Mbps. RKF uses data consumption rate and wireless link speed estimates to claim that only 0.04% of RLAN capable devices will be transmitting at a given moment, but a tenfold data usage increase over what RKF is assuming would mean that 0.4% of all RLAN capable devices would be transmitting at a given moment instead of 0.04%. And there is every reason to believe that usage rates would be still higher in 2030, 2035, 2040 and beyond.

4. Unjustified spectrum loading assumptions: RKF assumes "spectrum loading will be even across all the contemplated channels in the unlicensed bands,"[28] meaning that the 2.4 GHz, 5 GHz, and 6 GHz bands would all be used proportionately based on the available spectrum in each. However, the fact that the proposed 6 GHz RLAN allocation would be much wider than the contiguous bandwidth available in other Wi-Fi segments – 1.2 GHz, as compared to 72 MHz in the 2.4 GHz segment and 480 MHz in the 5 GHz segment – strongly suggests that many data-heavy applications with significantly higher average transmission duty cycles, such as Wi-Fi security cameras, will be more likely to use the 6 GHz band. If that occurs, the usage rate in the 6 GHz band will be driven even higher.

The impact of these unjustified assumptions on RKF's predicted RLAN interference levels is huge. For example, using the 5.3% outdoor use factor from the CEPT ECC Report and increasing the usage rate to 0.4% as discussed above results in an increase in predicted interference to SDARS operations that exceeds the RKF proposed interference threshold by 9.8 dB. The calculation of this harmful interference is shown in Table 1 below.

[28] RKF at 13. *See also* May RKF Letter at 6.

Table 1.

Uplink Link Budget Using Adjusted Interference Calculations

Parameter	Value	Notes
SDARS Carrier Power at satellite receiver	-117.4 dBW	Manufacturer specification for tolerable power
SDARS Noise Power at satellite receiver	-132.5 dBW	Thermal noise
RKF Interference to noise ratio threshold	-21.9 dB	RKF claimed interference ratio
Interference Power at satellite receiver	-154.4 dBW	RLAN interference level (no interference from FS, BAS, CARS or LTTS considered)
SDARS satellite receiving antenna gain	29.0 dBi	Manufacturer specification for uplink antenna gain
Uplink free space path loss	201.2 dB	
Interference Power from earth	17.8 dBW, or 60.4 W	Aggregate ground interference power from proposed RLAN transmitters operating within the 4.5 MHz single carrier satellite radio uplink band
Interference Power RLAN Transmitter	-73.0 dBW/Hz	Single device interference spectral density for a 1 watt 20 MHz Wi-Fi carrier
RLAN Transmitters to meet RKF interference threshold	268	
RLAN Transmitters in RKF proposal (adjusted)	2,623	Referenced in text below
Exceedance of RKF-Calculated Interference Ratio	9.8 dB	Referenced in text below

We can estimate the number of interferers that would impact reception of the Sirius XM service. Assuming for simplicity that an RLAN transmitter resembles a 1-watt[29] 20 MHz Wi-Fi carrier, then there is a 15.5 MHz wide portion of spectrum in which a 20 MHz carrier can be centered and still overlap the 4.5 MHz Sirius XM feeder link. RLAN proponents are seeking

[29] Because Sirius XM's calculations are based on a 1 watt power level, the assertion in the June RKF Letter that imposing a 1 watt limit on emissions of outdoor 6 GHz RLAN devices pointing more than 30 degrees above the horizon would be an effective mitigation technique (June RKF Letter at 5) is clearly false. Moreover, interference to SDARS would not be limited to devices pointing at a 30 degree elevation angle or greater. For example, the elevation angle for RLAN devices in New York City to Sirius XM's XM-4 satellite at the nominal 115° W.L. location will be only 27 degrees, and for RLAN emitters in Seattle, the elevation angle to XM-3 at the nominal 85° W.L. location will be 25 degrees.

access to 1200 MHz of 6 GHz spectrum, so 1.29% (15.5 MHz/1200 MHz) of RLAN carriers will affect a single Sirius XM feeder link. RKF projects there will be 958,062,017 devices in 2025. As discussed above, we use the reasonable assumption that 0.4% of those will be transmitting at any given moment and that 5.3% of those transmitters will be outdoors. That produces a total of 203,109 simultaneous outdoor RLAN transmissions, of which 1.29%, or 2,623 would affect a single Sirius XM feeder link.

Table 1 demonstrates that the RKF claimed Interference to Noise ratio of -21.9 dB equates to 268 simultaneous transmitters interfering with a single Sirius XM carrier. We can reasonably expect, however, that there will be 2,623 active interferers at any given moment into a Sirius XM feeder link – an order of magnitude higher than that allowed under the RKF proposed threshold. Reasonable and conservative wireless environment assumptions would result in RLANs exceeding the RKF proposed interference threshold by 9.8 dB in 2025.

This interference value would be well above the threshold that could cause muting of the Sirius XM signal received by satellite radios.

III. THE GLOBALSTAR PETITION HIGHLIGHTS THE RISKS AND HARMS ASSOCIATED WITH UNLICENSED DEVICE DEPLOYMENT IN SATELLITE UPLINK SPECTRUM

The Globalstar Petition provides a real-world example of the drawbacks of using optimistic assumptions in projecting interference risks from unlicensed devices and shows how, even with intended safeguards in place, such devices can cause aggregate interference that endangers satellite services. Globalstar's experience validates the concerns expressed above regarding unrealistic assumptions underlying the RKF analysis and underscores the difficulties of constraining the deployment of unlicensed devices and the resulting interference problems.

While the Globalstar uplinks are in a somewhat lower frequency band than Sirius XM's, the U-NII-1 band that covers 5150-5250 MHz, the analysis in the Globalstar Petition provides a solid analog for how the proposed 6 GHz unlicensed RLAN operations could affect reception of Sirius XM's satellite signals.[30] The 6 GHz RLANs will operate in much the same fashion as 5 GHz Wi-Fi and can be expected to have a similarly rapid adoption rate. Moreover, similar to Sirius XM satellites, the Globalstar constellation uses small downlink beams to serve customers, but its satellites receive signals and interference from a large area.

As the Globalstar Petition explains, just a few years after the Commission modified its U-NII-1 rules to allow outdoor deployment of devices and increased power levels, Globalstar is already measuring a 2 dB noise floor increase in its satellites' uplink receivers during the day over the United States and a 1 dB noise floor increase during the night.[31] To ensure that these readings were caused by interference and not a technical fault, Globalstar also measured the noise floor

[30] RKF notes that the broad term RLAN encompasses a number of services, including U-NII. *See* RKF at 4 n.3 (while "Wi-Fi is one type of RLAN, this study applies to other RLANs with [U-NII] operating characteristics").
[31] Globalstar Petition at 11.

in this band over ocean regions and found no change in noise floor levels.[32] The 2 dB increase observed by Globalstar was double what proponents of the U-NII-1 rule revisions had predicted would be the peak interference effects from the regulatory changes.[33]

Sirius XM used the information in the report of Roberson and Associates, LLC ("Roberson Report") submitted with the Globalstar Petition to estimate the aggregate interference power level being transmitted from the ground that would result in a 2 dB increase in the noise floor, as shown in Table 2 below. Table 3 uses that calculated aggregate interference level to predict the effect on Sirius XM satellites if a similar noise floor increase occurred in the SDARS uplink band.

Table 2:

Calculation of Interference Power Density on the Ground in Globalstar Frequencies

Parameter	Value	Unit	Source/Calculation
Globalstar Satellite Antenna Gain	6.37	dBi	Roberson Report at 41, Table 4
Globalstar Receiver Temperature	509.6	K	*Id*.
Noise Power Density at Globalstar Satellite	-201.53	dBW/Hz	-228.6 + 10log(509.6)
Measured Noise Floor Increase from Interference	2	dB	Globalstar Petition at 2
Noise + Interference Power Density at Globalstar Satellite	-199.53	dBW/Hz	Noise Power Density + 2
Interference Power Density at Globalstar Satellite	-203.86	dBW/Hz	10log[10^(-199.5/10) - 10^(-201.5/10)]
Globalstar Uplink Free Space Path Loss	169.86	dB	20log(1414km) + 20log(5250MHz) +32.45
Interference Power Density at the Ground Necessary to Produce a 2 dB Noise Increase at the Globalstar Satellite	**-40.37**	**dBW/Hz**	-203.86-AntennaGain (6.37) + Path Loss (169.86)

Applying the -40.37 dBW/Hz spectral power density demonstrated by the Globalstar noise increase readings to a 4.5 MHz Sirius XM channel bandwidth in the SDARS feeder link spectrum would be equivalent to 413 W[34] of aggregate interference power affecting Sirius XM within only a few years. Using the Globalstar measurement as a model for proposed RLAN deployments, the following table determines the associated impact on the received signal at a Sirius XM satellite.

[32] *Id.*

[33] *Id.* at 2 n.7.

[34] Converting the -40.37dBW/Hz value for interference power density at the ground to reflect the typical SDARS channel bandwidth of 4.5MHz results in 26.16 dBW/4.5MHz, or 413W in the 4.5 MHz channel.

Table 3:

Effect of Increased Interference Power Density on Sirius XM

Parameter	Value	Unit	Source/Calculation
7 GHz Interference Power Density (from 5 GHz Globalstar measurement)	-40.37	dBW/Hz	Derived in Table 2
Sirius XM Uplink Free Space Path Loss	201.2	dB	Geostationary altitude at Sirius XM uplink frequency
Sirius XM Satellite Antenna Gain	29	dB	Satellite parameter
Sirius XM Satellite Receiver Temperature	900	K	Satellite parameter
Sirius XM Noise Power Density at the Receiver	-199.1	dBW/Hz	-228.6 + 10log(900K)
Interference Power Density at Sirius XM Satellite	-212.6	dBW/Hz	-40.36 – PathLoss (201.2) + Antenna Gain (29)
Noise + Interference Power Density at Satellite	-198.9	dBW/Hz	10log[10^(-199.1/10) + 10^(-212.6/10)]
Noise Density Increase Due to Interference	0.19	dB	-198.9 – (-199.1)
Interference to Noise Ratio	-13.51	dB	-212.6 – (-199.1)

The above table shows that if Sirius XM were to experience the same level of interference in its feeder link band that Globalstar has measured in the 5 GHz band, the resulting interference to noise ratio would be -13.51 dB. This is 8.4 dB worse than RKF's estimate that the maximum interference to noise ratio produced by the proposed RLAN operations into satellite receivers would be -21.9 dB.[35] Moreover, RKF's interference predictions purport to reflect the interference scenario in 2025, but Globalstar's experience shows elevated levels of interference occurred only a few years after the Commission changed the U-NII-1 rules to allow outdoor devices. RKF also states that it assumed "[s]ignificantly higher EIRP above 30° elevation of 1 watt (30 dBm) as compared with U-NII-1 rules which limit maximum EIRP to 125 mW (21 dBm)."[36]

The fact that RKF's long-term projections of interference using greater assumed EIRP levels are so much lower than the results stemming from Globalstar's actual experience within just a few years clearly reinforces Sirius XM's arguments above that the assumptions underlying the RKF analysis are unreasonable. Additionally, this impact can be expected to materially increase over time as more units are deployed, causing further interference to satellite radio operations.

[35] RKF at 4.

[36] *Id.* at 11; *see also* June RKF Letter at 5.

Significantly, the increased noise floor already observed in the Globalstar spectrum occurred despite modest Commission attempts to monitor the deployment of U-NII-1 devices. In an effort to prevent interference, the Commission imposed a reporting requirement on any party that deployed more than one thousand outdoor U-NII-1 access points in the United States and mandated that filers also acknowledge their responsibility to take corrective action if the deployment caused harmful interference to licensed services.[37] Globalstar observes that only four parties have filed the required notification, despite indications suggesting that outdoor U-NII-1 devices have been broadly deployed.[38]

Thus, the Globalstar Petition should serve as a warning to the Commission of the perils associated with relying on claims by interested parties that interference risks from unlicensed devices are minimal, especially where the unlicensed devices would share spectrum with satellite uplink operations. In addition, the facts of the Globalstar Petition underscore the inadequacy of regulatory efforts to constrain unlicensed device deployment and resulting interference. Extrapolating the observed effects of RLAN devices in the 5 GHz uplink spectrum used by Globalstar to the SDARS feeder link bands clearly demonstrates that RKF's predictions of compatibility are baseless – in just a short period of time, 6 GHz RLANs could have a devastating impact on SDARS service quality. Globalstar's experience confirms that the Commission should exercise extreme caution before allowing any additional unlicensed devices to share a band used for satellite uplinks.

CONCLUSION

RKF ignores the existing challenges that impede Sirius XM's ability to achieve its performance goals and seriously understates the adverse impact of introducing RLAN operations in the 7025-7075 MHz band. Adding the aggregate interference from RLAN devices to the sources of in-band and out-of-band interference Sirius XM already must contend with would unacceptably impair the quality of SDARS service to tens of millions of users. Accordingly, the Commission should reject proposals to permit RLAN deployment in the 7025-7075 MHz band.

[37] Globalstar Petition at 8 & n.20.

[38] *Id.* at 10.

SiriusXM SATELLITE RADIO

CERTIFICATION OF PERSON RESPONSIBLE FOR PREPARING ENGINEERING INFORMATION

I hereby certify that I am the technically qualified person responsible for preparation of the engineering information contained in the foregoing response, that I am familiar with Part 25 of the Commission's rules that I have either prepared or reviewed the engineering information submitted in this response, and that it is complete and accurate to the best of my knowledge and belief.

Terrence R. Smith
Chief Engineering Officer
Sirius XM Radio Inc.

Dated: June 22, 2018